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(54) Improvements in the production of nonwoven webs using electrostatically charge conveyor belt

(57) A web of continuous filaments is produced and deposited on a moving porous conveyor in the form of a continuous web. The filaments carry an electrostatic charge of a first polarity, usually negative, which is either acquired or externally applied. The porous conveyor belt is made from a dielectric material. A charge of an opposite polarity is applied to the conveyor belt in an area just upstream of the deposit of the filaments. The filaments are thus attracted to and adhere to the belt. The charge to the conveyor belt is preferably applied by an insulated bar spaced from the belt and having a series of high voltage electrodes.

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Description

Cross Reference

[0001] This application claims the benefits of copending Provisional Application No. 60/082,101, filed April 17, 1998.

Background of the Invention

[0002] This invention relates to improvements in production efficiencies of a nonwoven web in a process wherein fibers or filaments of a polymer are continuously deposited on a porous moving conveyor and are consolidated into a fabric.

[0003] Nonwoven fabrics comprise fibers or filaments which are formed as a flat web and are bonded together by processes other than weaving. Some processes start with individual fibers, which are carded or otherwise formed into a web and bonded by the use of heat or adhesives. In other processes, referred to as meltblowing or spunbonding or variants thereof, a molten polymer is extruded from a spinning head to produce strands, and a high flow of air is employed to elongate or attenuate the strands. The strands, in the form of continuous filaments or fibers, are then collected on a porous moving conveyor for subsequent processing.

[0004] Spunbond webs have been produced for more than thirty years, and the basic techniques for producing such webs are well known, as exemplified in U.S. patent no. 3,302,237, 3,325,906, 3,655,305, 3,502,763, 5,397,413 and many others, incorporated herein by reference. The production of meltblown webs, for example, is described in U.S. patent no. 3,849,241. Spunbond and meltblown webs may be combined to form a single fabric, as described in U.S. patent no. 4,041,203. These layered fabrics can be produced on a single line, and are referred to, for example, as SM, SMS, and SMMS fabrics, with the letter designating the type of fabric, spunbond and meltblown.

[0005] Especially in connection with a spunbonding process, it is known to apply an electrostatic charge, such as a DC charge, to the filaments before they reach the conveyor. Since the filaments carry the same charge, they tend to repel each other and are more uniformly deposited on the conveyor. The use of electrostatics is described in U.S. patents no. 4,233,014, 4,208,366, 4,081,856, 5,397,413, and 5,762,857.

[0006] Quite apart from the application of electrical charge by an external device, however, the operation of modem high speed equipment often causes an electrostatic charge, usually a negative charge, to be built up on the filaments as they are being attenuated and processed. This can cause problems with the production of webs having successive layers of filaments, since the layers tend to repel each other. Also, press rolls are employed to compress the initial deposit of a filament layer, and the web may tend to cling to the roll and cause defects in the web. The transport of the web from the conveyor to the bonding area can also present problems. These problems are exacerbated by increasing line speeds, increasing web basis weights and increasing the number of layers, since the static charge tends to accumulate.

[0007] In order to alleviate the problem with the press rolls, it is known to provide an antifriction surface on the roll or to use an applied lubricant such as a silicone spray, but the presence of foreign materials is not acceptable to many customers. Despite many recent advances in the art, the problem of static buildup has continued to exist, and this factor limits maximum machine speed and overall efficiency.

Summary of the Invention

[0008] In accordance with the present invention, a web of continuous filaments is produced and deposited on a moving porous conveyor In the form of a continuous web. The filaments carry an electrostatic charge of a first polarity, usually negative, which is either acquired or externally applied. The porous conveyor belt is made from a dielectric material. A charge of an opposite polarity is applied to the conveyor belt in an area just upstream of the deposit of the filaments. The filaments are thus attracted to and adhere to the belt. The charge to the conveyor belt is preferably applied by an insulated bar spaced from the belt and having a series of high voltage electrodes.

[0009] If an additional layer of filaments is to be deposited on the first layer at a position downstream of the first, a second electrostatic bar may be positioned over the moving web at a location just prior to deposit of the second layer. An electrostatic charge of a given polarity, for example, positive, is applied to the web in order to attract the negatively charged filaments deposited at the second location.

[0010] In addition, if press rolls are used to compress the web at various locations, these rolls may comprise a dielectric surface which is charged with a polarity which will repel the charge carried by the fiber web, thus preventing pick-up of the web by the roll.

[0011] Finally, a neutralizing bar may be positioned across the web near the exit end of the conveyor. An opposite polarity charge may be applied to the web to neutralize the attractive forces between the web and the conveyor, in order to facilitate the removal of the web for subsequent bonding.

[0012] The method and apparatus of the present invention provide many direct and important benefits, such as allowing operation of a spunbond line at higher rates of speed and higher basis weights, with substantially fewer defects, as well as improved basis weight uniformity.

Brief Description of Drawing

[0013]

Figure 1 is a schematic of a production line for making spunbond-meltblown-spunbond fabrics (SMS), and additionally illustrating electrostatic charging devices employed in connection with the present invention.

Detailed Description

[0014] Figure 1 generally shows a pair of spaced spunbond lines or beams 10 and 12, with a meltblown line 14 positioned between the two beams. A molten polymer, such as a polyolefin (polyethylene) or polypropylene or various blends), polyester, polyamides, and the like are heated and pressurized by an extruder 16 in lines 10 and 12. The molten polymer is fed through filter 18 and gear pump 20 to an extrusion head or spin beam 22 containing a spaced array of small extrusion openings to produce a large number of continuous filaments 24. The filaments are initially cooled by the surrounding air and are passed through a slot drawing device 26 charged with a high flow of air from a suitable source 27. The device 26 comprises a downwardly tapering passage causing elongation or attenuation of the filaments. The filaments exit the slot attenuator in finer form, as shown at 28, whereupon they are deposited on a porous conveyor belt 30.

[0015] The meltblowing station 14 has a comparable operation, in that an extruder 32 forces molten polymer through a filter 34 and a pump 36 into an extrusion head 38 containing small orifices. In this case, however, hot air from a suitable source 40 is impinged on the extruded polymer near the point of extrusion. This typically produces fine fibers 42, which are deposited directly on the spunbond web of filament 28. The final spunbond beam 12 then deposits a final layer of filaments 44 on the meltblown layer. The composite three layer web 45, moving on the conveyor belt 30 is then transferred off the belt to a bonding station, such as a pair of heated calendar rolls 46, on of which rolls is embossed, to point bond some of the filaments and fibers in the web.

[0016] At each of the web deposit stations, a suction box 48 is provided beneath the porous conveyor belt 30 to allow the filaments or fibers, moving in high velocity air, to be evenly deposited on the conveyor.

[0017] In a conventional spunbonding process, such as that described above, it is known that friction causes the filaments to pick up a static charge, since the polymers employed are dielectric materials. It is also known to intentionally apply a static charge to the filaments either before they enter the attenuator or after exit. Suitable charging techniques are described in U.S. patent no. 5,762,857. A charging bar 50, containing a large number of electrodes arranged in a line in an insulating material, is connected to a high voltage source adjustable up to 30 KV or higher. The charging bar 50 has a length coextensive with the filament array and is spaced from the filaments 28. A ground bar 52 is spaced from the filaments 28 on the other side. The filaments receive a charge, usually a negative charge from a DC voltage source, as they pass through the gap. This corona charge causes the like-charged filaments to repel each other and causes a more uniform web to be deposited.

[0018] Regardless of how the polymer filaments acquire a charge, problems can arise in subsequent processing. For example, press rolls 54 are usually employed downstream of the area of deposit to compress the web prior to the deposit of the next layer. The web tends to cling to these rolls, causing unacceptably defects, with the problem increasing heavier basis weights and higher line speeds. The same problem may arise when the web is transferred from the exit end of the conveyor to the bonding station.

[0019] If more than one spunbond beam is being employed to produce a web, an additional problem is encountered. When the second spunbond layer is deposited, it carries a charge having the same polarity as the web on the conveyor, and the two layers tend to repel each other.

[0020] In accordance with a first aspect of the present invention, an electrostatic charge, of opposite polarity to that on the spunbond filaments, is applied to the conveyor belt 30 just upstream of the area of deposit of the filaments. In order to receive a static charge, the belt is made of a nonconductive or dielectric fabric, such as an open mesh woven polyester fabric.

[0021] A static charging bar 60 having a large number of pointed electrodes, is positioned closely adjacent to the conveyor belt 30, and the bar 60 is coextensive with the width of the belt. It has been found that the bar should be positioned between one and four inches from the belt at a DC charge level of 20-30 kV from a power source 61. If the bar is too close to the belt, or is operated at higher voltage, arcing can occur. If the bar is too far away from the belt, or is operated at a lower voltage, an ineffective charge is applied. In the embodiment shown, the charge bar 60 is positioned adjacent the conveyor as it passes over a grounded return roll 62 of the conveyor. Since the filaments 28 carry a negative charge, a positive charge is applied to the fabric of the conveyor. This causes the filaments to be attracted more strongly to the conveyor and to lie in a flatter relationship with the conveyor surface.

[0022] As indicated previously, typical spunbond operations employ more than one beam in order to produce more uniform, layered webs. In such case, the first web of filaments 28 may be provided with an additional static charge just prior to deposit of the second layer 44. This is likewise accomplished by positioning a second charging bar 64 above the width of the conveyor upstream of the second beam 12 and applying a positive charge to the first layer, which will attract the negatively charged

second layer 44. In this case, a ground plate 66 is placed beneath the conveyor opposite the charge bar 64 to cause movement of ions toward the surface of the web.

[0023] In order to additionally discourage pick up of the web by the press rolls 54, additional charging bars 68 may be located adjacent to the rolls to induce a charge on the rolls to repel the web.

[0024] Finally, a neutralizing charging bar may be positioned across the web, such as at 70, near the exit of the web from the conveyor, to reduce or neutralize the charge on the web, in order to facilitate transfer of the web to the bonding station. For example, if the web carries a net positive charge at this stage, a negative charge will be applied, to at least partially neutralize the charge on the web.

[0025] In trial runs, at line speeds of 165 to 272 meters per minute, a charge of +1.5 to +3.75 kV was applied to the belt by the bar 60. After laydown by the beam 10, this charge was reduced to a charge of +1.0 to +2.15. Charging of the first web by the second bar resulted in a charge on the belt and first layer of +7.8 to +8.4. After deposit of the second oppositely charged web, the charge was reduced to +4.28 to 4.75 kV. The neutralizing bar 70 then applied a negative charge to reduce the charge to +1.15 to 2.26 kV.

[0026] The charging bars and power supplies employed herein are commercially available, for example, from SIMCO in Hatfield, PA, U.S.A. These devices are commonly referred as corona discharging devices.

[0027] During initial plant trials in the production of polypropylene SMS fabrics at the line speeds of 400 meters per minute, several additional benefits were noted. During production, one frequent problem is that the porous conveyor belt may become clogged in spots with solidified polymer drips. This causes holes in the web because suction air cannot pass through and attract the filament in the blocked areas.

[0028] A trial was run using a conveyor contaminated with drips, with the electrostatic power off and then turned on. A Measurex system was used to quantify web defects. Use of the system of the present invention resulted in a reduction of defects by 75%, or from one in every 3,000 linear yards to one in every 12,402 linear yards. This indicates that filaments are being attracted to the clogged areas, even though no suction is available.

[0029] The basis weight of the web was also continuously evaluated with the system turned off and on. It is desirable to produce a web of uniform basis weight. The range of weights was 13.91 to 22.54 with charging of the conveyor turned off and 14.2 to 20.62 with the system turned on.

[0030] Web uniformity analysis using the Systronics web formation analysis system showed that the standard deviation of uniformity improved. Hydrohead was increased to an average of 140 mm versus 130 mm, indicating a reduction in pin holes.

[0031] From the above, it may be seen that the system of the present invention offers several important and immediate benefits in the production of spunbond nonwovens and composites. These benefits include higher production rates at higher basis weights, fewer defects, and less down time, for example, due to clogged conveyor belts.

Claims

1. Apparatus for the production of a nonwoven web, said apparatus comprising porous moving conveyor of dielectric material, first means for applying a first web of dielectric polymer filaments onto said conveyor, said polymer filaments carrying an electrostatic charge of a first polarity and being deposited at a first location on said conveyor, and first means spaced from said conveyor, for applying an electrostatic charge at a polarity opposite to that of the polarity of charge on the filaments, whereby to attract the filaments to the conveyor.

2. The apparatus of Claim 1 wherein the conveyor comprises an exit, and means are provided to neutralize the charge between said filaments and said conveyor adjacent said exit.

3. The apparatus of Claim 1 wherein said means for applying a web of dielectric polymer filaments to said conveyor comprises a spunbonding apparatus.

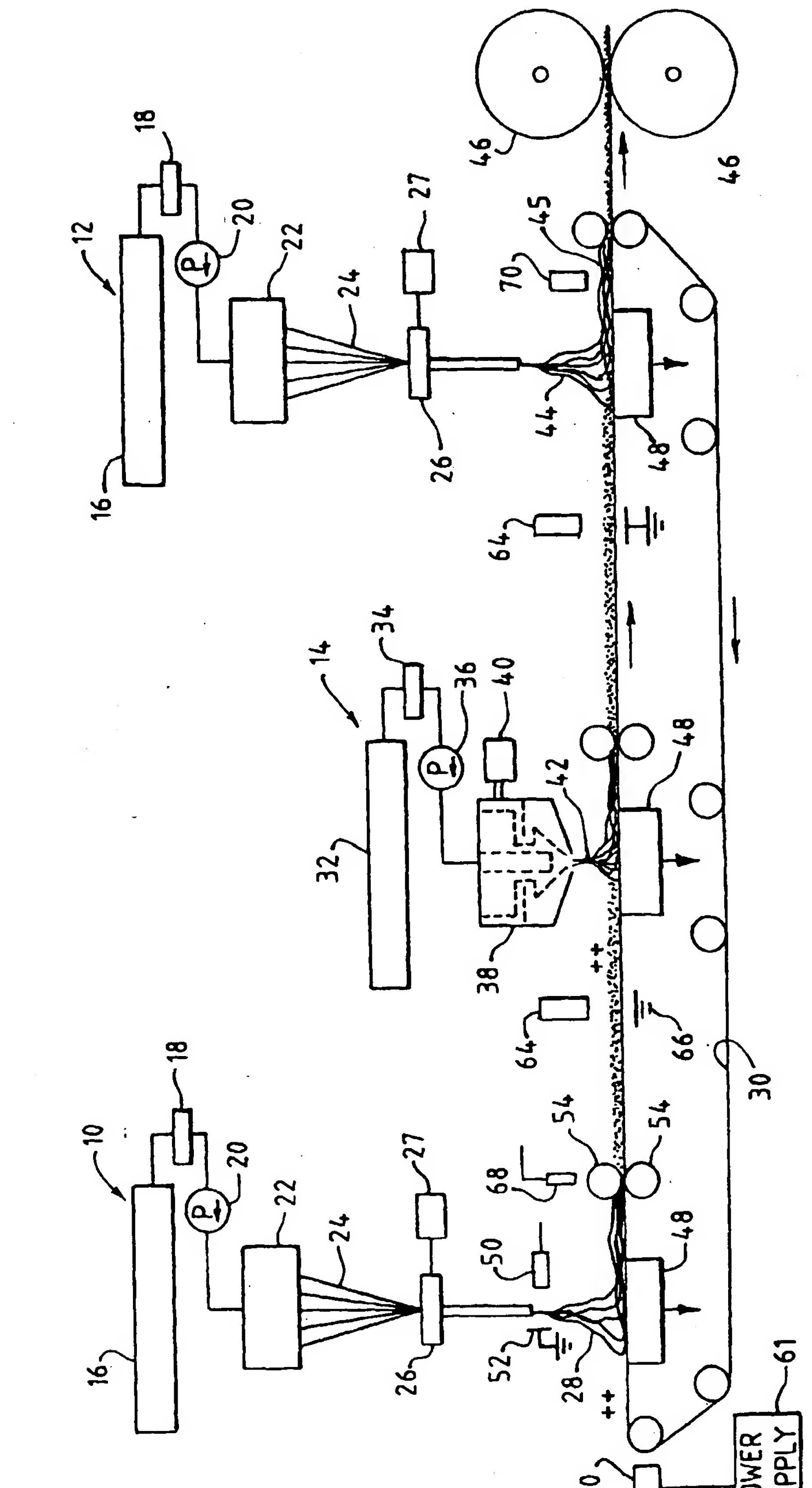
4. The apparatus of Claim 1, additionally comprising a second means for applying a web of dielectric polymer filaments onto said conveyor spaced from said first means, said second web of filaments carrying an electrostatic charge of said first polarity and being deposited on said conveyor at a second location spaced from said first location, and second means, spaced from said conveyor just ahead of said second location, for applying an electrostatic charge to said first web and said conveyor and having a polarity opposite to said first polarity, whereby said second web of filaments are attracted to said first web.

5. The apparatus of Claim 1 wherein a roll is compressively engaged with said first web of filaments, and wherein means are provided to electrostatically charge the surface of the roll to a polarity opposite to the first polarity of the filaments, whereby said filaments are repelled from said roll.

6. Process for producing a nonwoven web of filaments, said process comprising the steps of depositing extruded polymer filaments on a dielectric porous conveyor, said filaments carrying an electrostatic first charge having a first polarity, and applying a second electrostatic charge to said conveyor,

said second electrostatic charge having a polarity opposite to said first polarity.

7. Method of providing a layered spunbond web, said method comprising the steps of depositing a first layer of spun polymer filaments on a moving porous dielectric conveyor at a first location and depositing a second layer of spun polymer filament on said first layer at a second location spaced downstream from said first location, said first and second layers of filaments carrying the same electrostatic charge of a first polarity, applying to said conveyor an electrostatic charge having a polarity opposite to the first polarity just upstream of said first location, and applying an electrostatic charge having a polarity opposite to the first polarity to said first layer and the conveyor just upstream of said second location.


POWER
SUPPLY

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EUROPEAN SEARCH REPORT

Application Number
EP 98 12 3893

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP 0 702 994 A (KIMBERLY CLARK CO) 27 March 1996 (1996-03-27) * page 6, line 20 - line 53 *	1,3	D04H3/16 H01T19/00 G03G15/00
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TECHNICAL FIELDS SEARCHED (Int.Cl.6)
D04H
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	23 August 1999	V Beurden-Hopkins, S

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 98 12 3893

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